# An Updated Cost Review for Code for Sustainable Homes Level 5

**Summary**

The most recent official Department of Communities and Local Government cost review for Code for Sustainable Homes (CfSH) which was published in August 2011 (DCLG 08-2011) is now almost 3 years out of date. Since then the largest component of the additional costs for building to CfSH Level 5, that of Solar PV has reduced in cost by approximately 75% significantly reducing the overall cost of building to CfSH 5. This report re-estimates the extra-over costs for building 6 property types to CfSH Level 5 using updated prices for solar PV, fabric and rainwater recycling.

The impact of these updates is to reduce the average 27% extra-over costs published in DCLG 08-2011 to 11% making building to CfSH Level 5 more viable:

| | Base Build Cost (2010 Part L) | CfSH 5 Updated Extra-over Costs | Aug 2013 Updated Costs | DCLG Aug 2011 |
|---|---|---|---|---|
| **2 bed flat** | £71,111 | £6,031 | 8% | 33% |
| **3 bed flat** | £83,333 | £6,601 | 8% | 33% |
| **2 bed mid terrace** | £71,389 | £8,496 | 12% | 25% |
| **3 bed end terrace/semi** | £85,050 | £9,906 | 12% | 25% |
| **4 bed detached** | £112,840 | £13,914 | 12% | 25% |
| **large 4 bed detached** | £163,800 | £17,683 | 11% | 25% |
| **Average** | **£97,921** | **£10,439** | **11%** | **27%** |

In addition this report analyses the economic and environmental benefits to the owners of these properties built to CfSH Level 5 over that of building regulations 2010 part L. The average benefit is £17,700 which exceeds the average extra-over cost of £10,439 by more than £7,250. Annual CO2 emissions are reduced by on average 2.65 tonnes.

The 2 largest costs savings over DCLG 08-2011were by:

1. Reducing the solar PV cost model from £900 + £3750/kWp to £1,001 plus £867/kWp
2. Reducing flats, terrace and detached grey water recycling costs from £6,150, £4,700 and £4,700 respectively to £614, £1,150 and £1,775 for more cost effective rainwater recycling systems

Fabric costs actually rose as a result of using the recent Zero Carbon Hub FEEs costings.

The rest of this report documents the methodology behind these updated calculations.

# Methodology

**Summary**

- SAP modelling was used to determine the minimum amount of solar PV required to meet CfSH 5 using Zero Carbon Hub's FEES fabric standard
- Updated solar PV costs were obtained following discussions with solar PV suppliers and quotes available on the internet in Aug 2013
- Fabric costs were derived from those published by zero carbon hub in August 2012
- Rainwater recycling prices were derived from quotes received from suppliers in May 2013
- The additional, miscellaneous, less significant costs of meeting CfSH 5 minimum credit score of 84 were sourced from DCLG 08-2011
- The latest CfSH November 2010 credit rules were used (DCLG 11-2010)

**SAP Modelling and CfSH Compliance**

SAP modelling and CfSH Compliance was completed using Stroma's FSAP 2009 software which has a built in CfSH compliance tool, the solar PV component of each property was incrementally adjusted until CfSH energy requirements were just met[1].

**Property Types**

Six representative property types were modelled and their component areas were as follows:

| Areas ($m^2$)/Numbers | 2 bed flat | 3 bed flat | 2 bed terrace | 3 bed end terrace/semi | 4 bed detached | Large 4 bed detached |
|---|---|---|---|---|---|---|
| Floor $m^2$ | 64 | 75 | 80 | 90 | 125 | 180 |
| Roof (share) $m^2$ | 32 | 38 | 40 | 45 | 63 | 90 |
| Floor (share) $m^2$ | 32 | 38 | 40 | 45 | 63 | 90 |
| Wall (inc openings) $m^2$ | 40 | 45 | 60 | 70 | 160 | 190 |
| Windows/Doors (no.) | 5 | 6 | 13 | 16 | 26 | 30 |
| Outside walls (no.) | 2 | 2 | 2 | 3 | 4 | 4 |

The following assumptions were made about the properties:

a. they were either south east or south west facing, this reduces the output of the solar PV array and solar gain relative to a south facing home, but provides a reasonable mix of aspects for a large estate where not all homes can be optimally orientated to the south
b. mono-pitched roofs were assumed where the solar PV area was larger than 50% of the floor area

[1] Solar PV within a margin of 0.1 kWp/$m^2$/year, energy consumption within 1 kWh/$m^2$/year

c. they were located in Bath i.e. use local weather conditions
d. there was little or no shading of the properties
e. flats were assumed to be 2 storey, and to average out the heat losses they were assumed to have half a roof and half a ground floor area (i.e. representative of the average of a single ground floor and a single first floor flat)

**Fabric**

The ZCH FEEs fabric definitions and costs were used as these were deemed to be the most cost efficient way of meeting the code and also their costs have been more recently updated and published. The fabric assumptions used were as follows:

| Fabric Type | FEES | Unit |
|---|---|---|
| U value of wall | 0.18 | $W/m^2K$ |
| U Value of roof | 0.13 | $W/m^2K$ |
| U Value of floor | 0.15 | $W/m^2K$ |
| U Value of windows | 1.4 | $W/m^2K$ |
| G Value of windows | 0.7 | |
| FF Value of windows (Frame Factor) | 0.75 | |
| U Value of doors | 1.0 | $W/m^2K$ |
| Y Value | 0.05/0.04[2] | $W/m^2K$ |
| Air Permeability | 3 | $m^3/m^2/hr$ @ 50Pa |
| Heating | Gas Combi | |
| MVHR | × | |

The proposed ZCH FEEs standard, which is a working proposal for 2016 Part L Zero Carbon Building Regulations produces homes which should comply with Code for Sustainable Homes, the standard requires detached, semi and end terrace properties to meet a Design Energy Requirement (DER) of 46 $kWh/m^2/yr$ and 39 $kWh/m^2/yr$ for mid terraces and flats. The Ene 2 component of CfSH5 also requires DERs of 46 and 39.

In general the Zero Carbon Hub fabric costs were significantly higher than those of the DCLG 08-2011 'good fabric' standard despite having similar U values, but were a little lower than the 'Advanced Fabric' costs from DCLG 08-2011.

The floor area of the example ZCH properties differed slightly from that of this report, fabric costs were adjusted linearly in proportion to the difference in floor areas.

The resulting updated extra-over costs for fabric are:

| Property Type | Fabric Extra- |
|---|---|

[2] Detached, plus 3 bed flat

| | Over Cost |
|---|---|
| **2 bed flat** | £1,304 |
| **3 bed flat** | £1,528 |
| **2 bed mid terrace** | £2,632 |
| **3 bed end terrace/semi** | £3,434 |
| **4 bed detached** | £6,042 |
| **large 4 bed detached** | £8,771 |

These additional costs are versus the current building regulation standards i.e. 2010 Part L, and are likely to reduce with the implementation of 2013 Part L, although at the time of writing this report it is unknown what this standard is likely to be?

**Solar PV Requirements**

The minimum amount of solar PV to meet CfSH 5 is laid out in the table below, along with the percentage of roof area required and the updated costs and an estimate of those used in the Aug 2011 DCLG Extra-Over cost report[3]:

| | kWp | % roof area | Cost Aug 2013 | Estimated DCLG Cost Aug 2011 |
|---|---|---|---|---|
| **2 bed flat** | 2.6 | 49% | £3,255 | £10,650 |
| **3 bed flat** | 3.0 | 48% | £3,601 | £12,150 |
| **2 bed mid terrace** | 3.1 | 47% | £3,688 | £12,525 |
| **3 bed end terrace/semi** | 3.8 | 51% | £4,295 | £15,150 |
| **4 bed detached** | 4.5 | 44% | £4,902 | £17,775 |
| **large 4 bed detached** | 5.7 | 38% | £5,942 | £22,275 |
| **Average** | 3.8 | 46% | £4,281 | £15,088 |

The solar PV costs are reduced by 72% or almost £10,870 on average over the last 3 years.

The roof area used by the panels is on average 47%, which is above the government guidelines of 40%. This can be reduced to 34% on average by the use of higher cost, higher efficiency panels[4], but with an additional average cost of about £1,500 per system. However this was not deemed necessary for this analysis as mono-pitched roofs seem to be coming prevalent on estates of high sustainability homes. The cost model used was £1,001 fixed cost + £867 per kWp. A more detailed discussion of solar PV costs is contained in Appendix 1.

[3] £900 fixed + £3750 per kWp
[4] The base analysis assumes low cost mono-crystalline panels with conversion efficiencies of about 14%, higher efficiency panels are available with up to 20% conversion efficiency (i.e. Sunpower E21/Panasonic HIT)

No alterative renewable options were considered e.g. biomass, it is assumed that for all but the highest density multi-storey blocks of flats that solar PV is the cheapest and most feasible way of meeting CfSH 5. The assumption works well in relatively low density blocks of flats in the Bath & North East Somerset area but would require further analysis in denser urban environments where more than 3 storey blocks would make solar PV less feasible.

**Rainwater Recycling Costs**

ZCH 08-2011 assumed grey-water recycling was installed to meet the mandatory maximum consumption requirements of CfSH Level 5 of 85 litres/person/per day. This leads to extra-over costs of £6,150 and £4,700 for flats and detached properties respectively. For this purposes of this analysis rainwater recycling systems were used instead because:

a) they are cheaper, particularly if shared systems are employed
b) it appears that (over-sized) rainwater systems are generally being installed on estates built to CfSH 5 or 6
c) feedback on grey-water recycling systems suggest they can be problematic to maintain and the technology is still immature

As a result of getting quotes from suppliers, costs for rainwater recycling systems used in this analysis are £614 for flats, £1,150 for terraces and £1,775 for detached properties. More information is provided in Appendix 2.

**Remaining Miscellaneous Code Costs**

The remaining code costs (i.e. not ENE1, ENE2, ENE7 and WAT1) were calculated using the latest Nov 2010 CfSH credit scoring standard and were optimised to minimise costs while meeting the CfSH 5 requirement of greater than 84 points:

| Category | Name | Max Credits | Weight | Value of each credit | Points Achieved | Flat Cost | House Cost |
|---|---|---|---|---|---|---|---|
| **ENE** | Energy & CO2 (not ENE1,2) | 31 | 36.4% | 1.17 | 32.88 | £384 | £720 |
| **WAT** | Water (not WAT1) | 6 | 9.0% | 1.50 | 9.00 | £0 | £0 |
| **MAT** | Materials | 24 | 7.2% | 0.30 | 7.20 | £0 | £0 |
| **SUR** | Surface Water Run-Off | 4 | 2.2% | 0.55 | 2.20 | £0 | £0 |
| **WAS** | Waste | 8 | 6.4% | 0.80 | 6.40 | £0 | £0 |
| **POL** | Pollution | 4 | 2.8% | 0.70 | 2.80 | £0 | £0 |
| **HEA** | Health & Wellbeing | 12 | 14.0% | 1.17 | 9.33 | £450 | £450 |
| **MAN** | Management | 9 | 10.0% | 1.11 | 7.78 | £25 | £25 |
| **ECO** | Ecology | 9 | 12.0% | 1.33 | 6.67 | £0 | £0 |
| | Total | | 100.0% | | **84.26** | £859 | £1,195 |

The costs are largely based on DCLG 08-2011. More details are provided in Appendix 3.

**Summary of Costs**

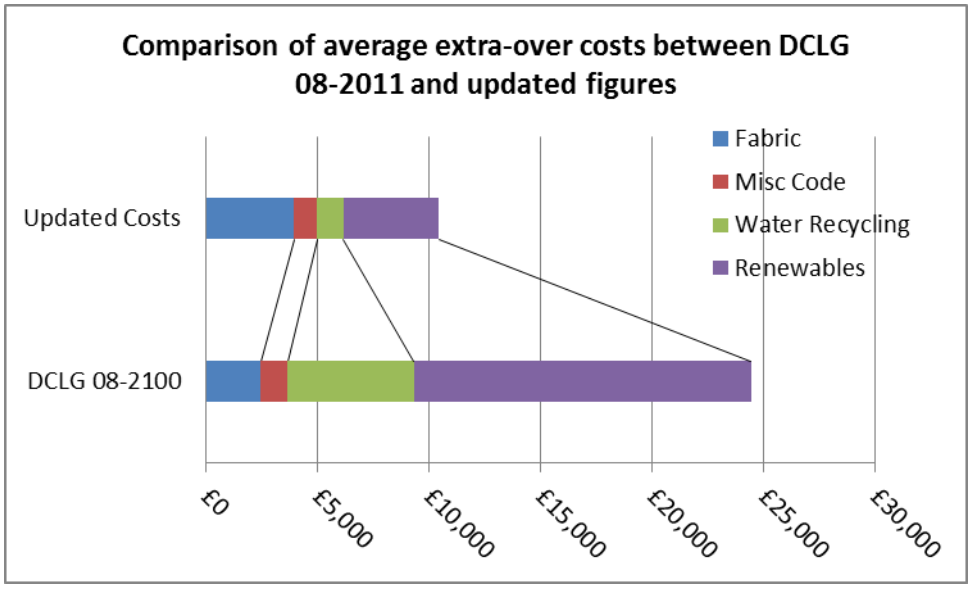
Overall the breakdown of the 4 major components of the extra-over costs presented above is as follows:

| | Base Build Cost (2010 Part L) | Floor Area | Fabric Extra Over | Solar PV kWp | Solar PV Cost | Rainwater Costs | Other CfSH Credits | Total Extra Over Costs |
|---|---|---|---|---|---|---|---|---|
| 2 bed flat | **£71,111** | 64 | £1,304 | 2.6 | £3,255 | £614 | £859 | **£6,031** |
| 3 bed flat | **£83,333** | 75 | £1,528 | 3 | £3,601 | £614 | £859 | **£6,601** |
| 2 bed mid terrace | **£71,389** | 80 | £2,632 | 3.1 | £3,688 | £1,150 | £1,027 | **£8,496** |
| 3 bed end terrace/semi | **£85,050** | 90 | £3,434 | 3.8 | £4,295 | £1,150 | £1,027 | **£9,906** |
| 4 bed detached | **£112,840** | 124 | £6,042 | 4.5 | £4,902 | £1,775 | £1,195 | **£13,914** |
| large 4 bed detached | **£163,800** | 180 | £8,771 | 5.7 | £5,942 | £1,775 | £1,195 | **£17,683** |
| Average | **£97,921** | **102** | **£3,952** | **3.8** | **£4,281** | **£1,180** | **£1,027** | **£10,439** |

## Discussion

**Impact of this update**

This update to the extra-over costs of Code for Sustainable Homes 5 has reduced the costs from a 27% uplift over properties built to 2010 Part L to 11%. This improvement comes mainly as a result of significant reductions in the largest 2 additional capital items i.e. renewables (solar PV) and water recycling:




| | DCLG 08-2100 | Updated Costs | Difference |
|---|---|---|---|
| **Fabric** | £2,469 | £3,952 | £1,482 |
| **Misc Code** | £1,200 | £1,027 | -£173 |
| **Water Recycling** | £5,667 | £1,180 | -£4,487 |
| **Renewables** | £15,088 | £4,281 | -£10,807 |
| **Total** | £24,424 | £10,439 | -£13,985 |

- Fabric costs have increased, but this is probably as a result of differences in methodology and costs between the ZCH FEEs standard and DCLG 08-2011
- This is offset by a significant reduction in the other costs i.e. renewables and water recycling

**Economic and Environmental Benefit**

The economic and environmental benefits of building to a more sustainable standard are often overlooked, particularly from the home owners' perspective. These benefits versus building the homes to minimum 2010 part L building regulations are however considerable:

| | Annual Solar PV kWh | Annual Gas Saving kWh | CO2 Saving kg | Extra Over Costs | Benefit of FIT plus Energy Savings over 20 years | Gain |
|---|---|---|---|---|---|---|
| **2 bed flat** | 2,154 | 1,171 | 1,649 | £6,031 | £11,406 | £5,375 |
| **3 bed flat** | 2,485 | 1,882 | 2,023 | £6,601 | £13,772 | £7,170 |
| **2 bed mid terrace** | 2,568 | 2,175 | 2,143 | £8,496 | £14,496 | £6,000 |
| **3 bed end terrace/semi** | 3,148 | 3,133 | 2,732 | £9,906 | £18,307 | £8,401 |
| **4 bed detached** | 3,728 | 3,939 | 3,288 | £13,914 | £21,068 | £7,154 |
| **large 4 bed detached** | 4,722 | 5,623 | 4,308 | £17,683 | £27,416 | £9,732 |
| **Average** | 3,134 | 2,987 | 2,690 | £10,439 | £17,744 | £7,305 |

The costs of building to a higher standard which average £10,439 are more than offset by the economic benefit to the home owner derived from energy savings and FIT tariffs of £17,287, an overall net benefit of over £7,305. CO2 savings of an average of 2.65 tonnes per year are also significant[5].

Large developers argue that house purchasers don't factor these in when purchasing a property but it could also be argued that developers don't necessarily sell the benefit either? Additionally the biggest economic impact from the suppliers perspective is likely to be on land value and not developers' profits.

## References

**DCLG 11-2010** – "Code for Sustainable Homes: Technical Guide", DCLG, Nov 2010

**DCLG 08-2011** – "Cost of building to the Code for Sustainable Homes: Updated Cost Review", Element Energy, Davis Langdon, Aug 2011

**ZCH 08-2012** – "Estimated Costs of Zero Carbon Homes", ZCH, Aug 2012

[5] More information on this analysis is provided in Appendix 4

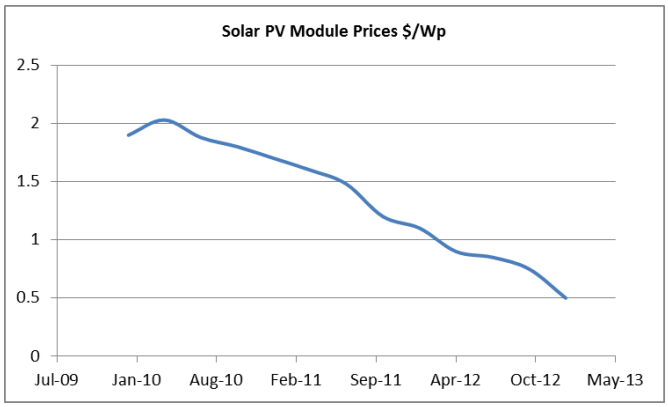
# Appendix 1: Solar PV (5 Aug 2013)

**Evidence for Solar PV Prices**

The report used a pricing model of £1001 fixed cost plus £867/kWp for solar PV, which compares with the August 2011 DCLG figure of £900 plus £3,750/kWp.

Evidence for this 'new' reduced cost model comes from a number of sources:

1. General price trends (euro-solar.de) indicate solar PV panel prices have reduced by a factor of 4 over the last 3.5 years:




2. Discussions with system suppliers who have verbally quoted wholesale purchase prices for panels below £500/kWp
3. Quoted internet wholesale prices (1 off, not volume discount, not installed) for example:
    a. Euro-solar.de May 2013 system price at £850/kWp (4 kWp)
    b. Swithenbanks for a 4 kWp system (supply only):

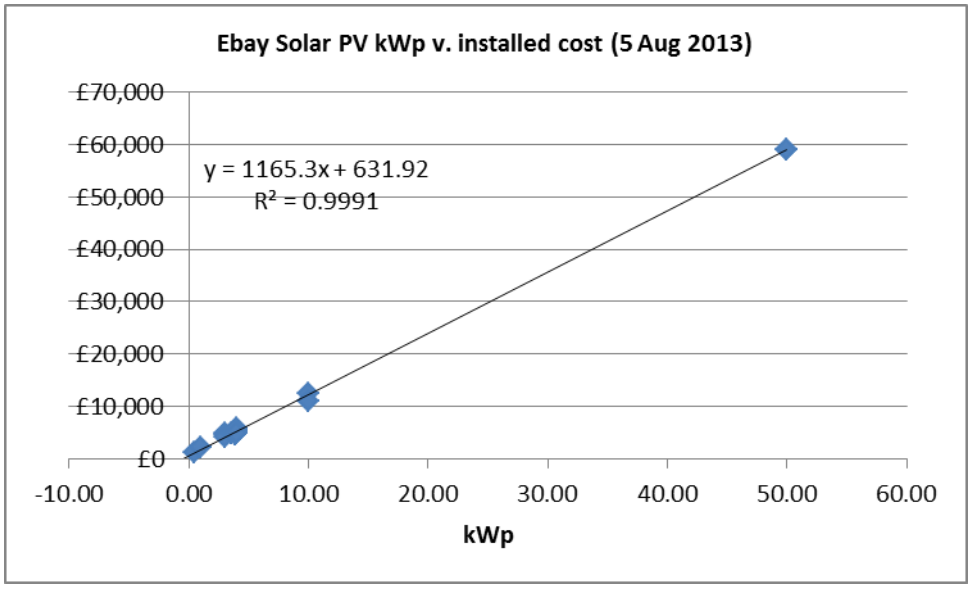
| Date | Medium Efficiency Panels | High Efficiency (Panasonic HIT) |
|---|---|---|
| May 2013 | £3200 | £3900 |
| Aug 2013 | £4100 | £5950 |

4. Ebay quoted system installed costs of about £5000 for a 4 kWp installed system (Aug 2013) [in May 2013 the figure was £4100).

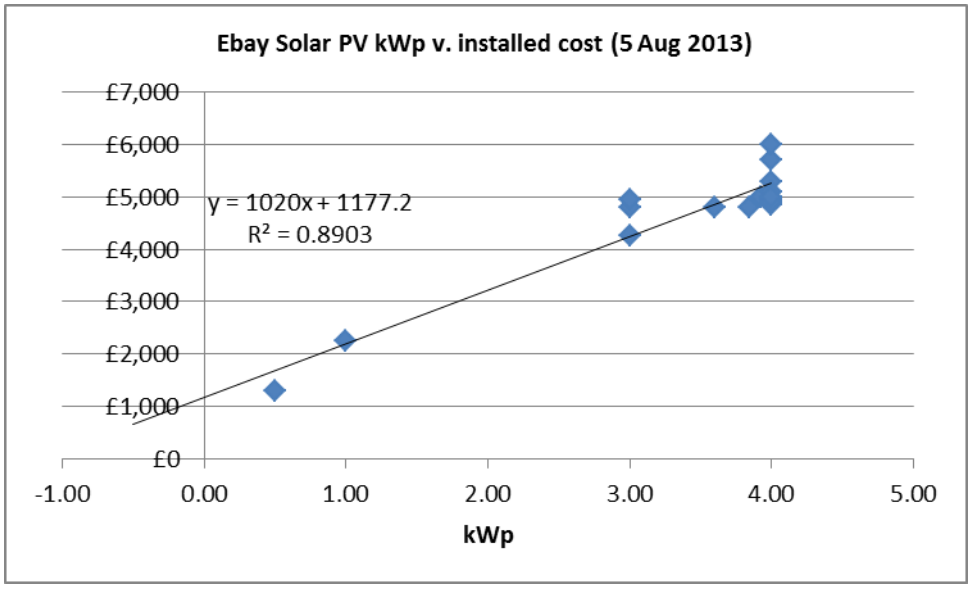
The above figures are for single installations, it is assumed for new builds that the systems would be installed in volume and would therefore attract a discount on the above prices. Telephone discussions with system suppliers provided a rough indication of volume discount and cost savings from not having to install scaffolding on new builds and no EPC costs. Suppliers indicated a 20% discount on their ebay prices for volumes of 20 properties at 4 kWp, but were reluctant to provide a quote. So for the purposes of this analysis a 15% volume discount was assumed.

**The solar PV model cost calculation**

21 quotes of installations of single installations of different sizes were obtained from ebay, including systems from 0.5 kWp to 50 kWp and these were plotted versus price:




A subset of this data (18 quotes) was then selected with a maximum installation size of 4 kWp:




A trend line was then plotted and the function defining this trend line (y = £1020x + £1177.2) was used as the basis for the 'model'. Following conversations with suppliers by phone who indicated volumes discounts of 20% for groups of 20 properties a conservative discount of 15% was assumed for volume which was applied to the model i.e. 15% * (£1020 * kWp + £1177) = £867 * kWp + £1,001. This for example implies an installation cost of £4468 for a 4 kWp system.

**The solar PV mode cost calculation – high efficiency panels**

For properties where roof space is limited high efficiency panels were specified which require less roof area for the same output, but which are also more expensive than the commodity medium efficiency mono-silicon panels.

Unfortunately it is difficult to find published quotes for installation of high efficiency panels – only one company quotes on ebay and their prices seem high if you compare the difference in wholesale prices between medium and high efficiency panels. There are two main suppliers for the high efficiency panels – Panasonic (19%, HIT series) and Sunpower (20%, E20). Only the more expensive Panasonic panels are available for direct purchase with panel prices being available online; the cheaper Sunpower can only be purchased via accredited installers who don't quote prices online and were reluctant to quote prices over the phone.

Because of limited number of quotes available for Panasonic panels and the unavailability of data from Sunpower a hybrid approach was used to determine the cost of high efficiency panel systems, which made the following assumptions:

1. The fixed costs (inverter, cabling, mounts) are identical to that of the medium efficiency systems (£1,001)
2. The variable costs (panels, and to a lesser extent inverters) were based on applying the ratio of wholesale panel costs (Panasonic (£900/kWp) versus best value medium efficiency panel £600/kWp) at www.Swithenbanks.co.uk with a 15% discount (indicated cost saving between Pansasonic and Sunpower panels) to the basic models variables costs of £867/kWp i.e. £867 * ( (100%-15%)*£900/£600) = £1235/kWp. This for example implies a volume installed price of £5942 for a 4 kWp installation

**Roof areas**

The analysis in this report produces solar PV areas greater than that of the 40% of roof area recommended in government guidelines. It is felt this is justifiable in greenfield 'eco' type development as the majority currently appear to being built with mono-pitched roofs which support greater south facing roof areas than traditional dual-pitched designs.

If for whatever reason (aesthetics, structure etc.) a smaller roof area must be assigned for solar PV then higher performance panels could be used, for example Panasonic HIT and Sunpower E21 panels which would reduce the average roof area down from 47% to 34%. This would increase the average solar PV installation price by £1000.

**Impact of Chinese Panel Tariff**

During June and July 2013 panel prices rose as a result of a proposed EU threat to apply a 47% average anti-dumping tariff on Chinese panels. As of 5 Aug 2013 a floor price of €560/kWp and a cap of 10 GW per year appears to have been agreed. Discussions with suppliers suggest that this will have no significant impact on prices and that prices might drop following a significant demand prior to the mooted 47% levy and therefore prices during June and July.

## Appendix 2: Rain water recycling costs

A mandatory element of CfSH 5 is a water consumption rate below 85 litres per person per day, which is typically achieved by the installation of rainwater recycling systems feeding toilets and washing machines. In the DCLG report from Aug 2011 the costs of the more expensive grey-water recycling systems were quoted at between £4,700 and £6,150. Experience of estates already built to CfSH 5&6 suggest builders are using more cost effective (shared) rainwater recycling systems to meet the standard. Quotes were obtained from a number of suppliers and the Rainwater Harvesting Association, the systems were sized using standard industry tools. All systems were assumed to be directly fed as opposed to indirect systems using header tanks, although both systems have similar costs.

Quotes included:

- May 2013: £1499 for 1 x 1750 litre tank system, up to 25% volume discount, install costs £500
- May 2013: £1999 for 1 x 3,500 litre tank system, up to 25% volume discount, install costs £500
- May 2013: £17,000 system plus £10,000 installation costs for high density block of flats with 44 flats and 80 occupants
- May 2013: £7,500 system cost plus £4,000 installation costs for a group of 10 terraces houses with 20 occupants
- Aug 2012: £95,000 50 x indirect grey water systems i.e. £1,900 each + install
- Aug 2012: £107,000 50 x direct grey water systems i.e. £2,145 each + install
- Aug 2012: £21,000 for a system to service 80 occupants in 36 flats, plus £500 per property install cost

**Shared systems for flats and terraces**

2 specifications were given to the Rainwater Harvesting Association:

1. 44 'Dense' flats, 80 occupants, 1500 $m^2$ roof area
2. 2 x 5 house terraces, single system, 20 occupants, 425 $m^2$ roof area

The quotes obtained were £27,000 and £11,500 respectively or £615 per flat and £1,150 per terrace.

**Detached Housing**

It was assumed that these would be installed on an individual/non-shared basis. Sizing was completed using the industry standard sizing tool, assuming the following 55 $m^2$ roof area, 643mm/yr annual rainfall, 2.5 occupants x 9000 litres per person toilet flush, 5000 litres per person washing machine and 1000 litres per person cleaning water. This indicated a tank size of 1384/litres, and annual 37,500 litre saving or 41 litres per day, reducing the standard non-rainwater consumption of 105 litres/person/day to 64 litres per day, below the CfSH requirement. Assuming a

conservative 15% volume discount on the materials (85% of £1500) plus a £500 per property installation cost suggests a price of about £1,775 per house.

## Appendix 3: Remaining Code Costs

The remaining code costs (i.e. not ENE1, ENE2, ENE7 and WAT1) were calculated using the latest Nov 2010 CfSH credit scoring standard and were optimised to minimise costs while meeting the CfSH 5 requirement of greater than 84 points:

| Category | Name | Max Credits | Weight | Value of each credit | Points Achieved | Flat Cost | House Cost |
|---|---|---|---|---|---|---|---|
| **ENE** | Energy & CO2 | 31 | 36.4% | 1.17 | 32.88 | £384 | £720 |
| **WAT** | Water | 6 | 9.0% | 1.50 | 9.00 | £0 | £0 |
| **MAT** | Materials | 24 | 7.2% | 0.30 | 7.20 | £0 | £0 |
| **SUR** | Surface Water Run-Off | 4 | 2.2% | 0.55 | 2.20 | £0 | £0 |
| **WAS** | Waste | 8 | 6.4% | 0.80 | 6.40 | £0 | £0 |
| **POL** | Pollution | 4 | 2.8% | 0.70 | 2.80 | £0 | £0 |
| **HEA** | Health & Wellbeing | 12 | 14.0% | 1.17 | 9.33 | £450 | £450 |
| **MAN** | Management | 9 | 10.0% | 1.11 | 7.78 | £25 | £25 |
| **ECO** | Ecology | 9 | 12.0% | 1.33 | 6.67 | £0 | £0 |
| | Total | | 100.0% | | **84.26** | £859 | £1,195 |

Costs were largely derived from DCLG 08-2011.

These costs are broken down as follows:

| | | Credits | Max Credits | Category | Points | Flat Cost | House Cost | Comment |
|---|---|---|---|---|---|---|---|---|
| ENE1 | DER | 9 | 10 | ENE | 10.57 | | | Accounted for elsewhere |
| ENE2 | FEE | 7 | 9 | ENE | 8.22 | | | Accounted for elsewhere |
| ENE3 - 1 | Energy Display Devices (electric) | 1 | 1 | ENE | 1.17 | £25 | £25 | 1 pt for electric, 1pt for heating fuel |
| ENE3 - 2 | Energy Display Devices (heat) | 1 | 1 | ENE | 1.17 | £50 | £50 | e.g. Savometer |
| ENE 4 | Drying Space | 1 | 1 | ENE | 1.17 | £15 | £75 | |
| ENE 5 - 1 | Appliance Leaflet/Tumble Dryer | 1 | 1 | ENE | 1.17 | | | |
| ENE 5 - 2 | A+ Fridge/freezer | 1 | 1 | ENE | 1.17 | £0 | £0 | Assumed included at no extra cost |
| ENE 5 - 3 | A Wash Machine/Dishwasher | 0 | 1 | ENE | 0.00 | £200 | £200 | |
| ENE 6 - 1 | Efficient External Lighting | 1 | 1 | ENE | 1.17 | £0 | £0 | |
| ENE 6 - 2 | Ext Light PIR Controls | 1 | 1 | ENE | 1.17 | £20 | £65 | |
| ENE 7 - 1 | Low Carbon Tech - 10% reduction (Solar PV) | 1 | 1 | ENE | 1.17 | £0 | £0 | Automatic from solar PV |
| ENE 7 - 1 | Low Carbon Tech - additonal 5% | 1 | 1 | ENE | 1.17 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ENE 8 | Cycle Storage | 2 | 2 | ENE | 2.35 | £194 | £425 | Assumed 1/2 cost, as often included in garage anyway, flat shared points with some free eco code points |
| ENE 9 | Home Office | 1 | 1 | ENE | 1.17 | £80 | £80 | |
| WAT 1 | Water | 5 | 5 | WAT | 7.50 | | | Rainwater, accounted for elsewhere |
| WAT 2 | External Water | 1 | 1 | WAT | 1.50 | £0 | £0 | Rainwater with external tap assumed |
| MAT 1 | Env Impact of Materials | 15 | 15 | MAT | 4.5 | £0 | £0 | |
| MAT 2 | Material Sourcing | 6 | 6 | MAT | 1.8 | £0 | £0 | |
| MAT 3 | Responsible Sourcing | 3 | 3 | MAT | 0.9 | £0 | £0 | |
| SUR 1 | Surface Water Management | 2 | 2 | SUR | 1.1 | £0 | £0 | Assumed rainwater system will deal with this? |
| SUR 2 | Flood Risk | 2 | 2 | SUR | 1.1 | £0 | £0 | |
| WAS 1 | Waste Storage | 4 | 4 | WAS | 3.2 | £0 | £0 | |
| WAS 2 | Construction Site Waste | 3 | 3 | WAS | 2.4 | £0 | £0 | |
| WAS 3 | Composting | 1 | 1 | WAS | 0.8 | £0 | £0 | |
| POL 1 | Glob Warm Pot of Insulants | 1 | 1 | POL | 0.7 | £0 | £0 | |
| POL 2 | Nox Emissions | 3 | 3 | POL | 2.1 | £0 | £0 | |
| HEA 1 | Daylight | 3 | 3 | HEA | 3.5 | £300 | £300 | |
| HEA 2 | Sound Insulation | 4 | 4 | HEA | 4.7 | £150 | £150 | |
| HEA 3 | Private Space | 1 | 1 | HEA | 1.2 | £0 | £0 | |
| HEA 4 | Lifetime Homes | 0 | 4 | HEA | 0.0 | £300 | £700 | |
| MAN 1 | Home User Guide | 3 | 3 | MAN | 3.3 | £25 | £25 | |
| MAN 2 | Considerate Constructor | 2 | 2 | MAN | 2.2 | £0 | £0 | |
| MAN 3 | Construct Site Impacts | 2 | 2 | MAN | 2.2 | £0 | £0 | |
| MAN 4 | Security (Secure by Design) | 0 | 2 | MAN | 0.0 | £660 | £530 | |
| ECO 1 | Eco Value of Site | 1 | 1 | ECO | 1.3 | £0 | £0 | |
| ECO 2 | Eco Enhancement | 0 | 1 | ECO | 0.0 | £150 | £250 | |
| ECO 3 | Protect Eco Features | 1 | 1 | ECO | 1.3 | £0 | £0 | Assumed part of B&NES planning app process |
| ECO 4 | Change in Eco Value of Site | 2 | 4 | ECO | 2.7 | | | Neutral Assessment |
| ECO 5 | Building Footprint | 1 | 2 | ECO | 1.3 | | | 1 point on average by default because of high densities required in B&NES |

## Appendix 4: Basis for Economic Analysis

The economic analysis suggests the economic and environmental benefit of the more sustainable homes versus homes built to 2010 Part L far outweigh their additional build costs:

| | Annual Solar PV kWh | Annual Gas Saving kWh | CO2 Saving kg | Extra Over Costs | Benefit of FIT plus Energy Savings over 20 years | Gain |
|---|---|---|---|---|---|---|
| **2 bed flat** | 2,154 | 1,171 | 1,649 | £6,031 | £11,406 | £5,375 |
| **3 bed flat** | 2,485 | 1,882 | 2,023 | £6,601 | £13,772 | £7,170 |
| **2 bed mid terrace** | 2,568 | 2,175 | 2,143 | £8,496 | £14,496 | £6,000 |
| **3 bed end terrace/semi** | 3,148 | 3,133 | 2,732 | £9,906 | £18,307 | £8,401 |
| **4 bed detached** | 3,728 | 3,939 | 3,288 | £13,914 | £21,068 | £7,154 |
| **large 4 bed detached** | 4,722 | 5,623 | 4,308 | £17,683 | £27,416 | £9,732 |
| **Average** | 3,134 | 2,987 | 2,690 | £10,439 | £17,744 | £7,305 |

The following assumptions were made in calculating these numbers:

1. Annual gas savings (kWh) were calculated by re-modelling the proposed ZCH/CfSH 5 properties using the lower minimum U values of building regulations 2010 Part L
2. FIT tariffs of 13.9p/kWh (< 4 kWp) and 12.6p/kWh (> 4 kWp) escalating at RPI for 20 years
3. Electricity Cost – 15p/kWh escalating at RPI + 3%
4. Electricity Export Cost –4.5p/kWh escalating at RPI + 3%, 50% exported
5. Gas Cost: - 5p/kWh –4.5p/kWh escalating at RPI + 3%
6. RPI at 2%
7. Panel degradation of 0.5%/year
8. Future cash flows discounted/PV'ed at 3.5%
9. Financing not included as it a cash for cash comparison

The more detailed results are as follows:

| | | | | | Year 1 income | | | | | 20 year income (PV-ed) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kWp | Solar kWh | Gas Savings kWh | FIT Rate £/kWh | FIT Income | Exports | Saving on Mains Electric | Savings on gas (v 2010 Part L) | Total Income/ Savings | FIT Income | Exports | Saving on Mains Electric | Savings on gas (v 2010 Part L) | Total Income /Savings | Extra-over costs | Economic Gain |
| 2 bed flat | 2.6 | 2154 | 1171 | £0.154 | £333 | £50 | £162 | £108 | £652 | £5,383 | £1,151 | £3,524 | £1,348 | £11,406 | £6,031 | £5,375 |
| 3 bed flat | 3.0 | 2485 | 1882 | £0.154 | £384 | £58 | £186 | £124 | £752 | £6,211 | £1,328 | £4,066 | £2,167 | £13,772 | £6,601 | £7,170 |
| 2 bed mid terrace | 3.1 | 2568 | 2175 | £0.154 | £397 | £60 | £193 | £128 | £777 | £6,418 | £1,372 | £4,201 | £2,505 | £14,496 | £8,496 | £6,000 |
| 3 bed end terrace | 3.8 | 3148 | 3133 | £0.154 | £486 | £73 | £236 | £157 | £953 | £7,868 | £1,682 | £5,150 | £3,608 | £18,307 | £9,906 | £8,401 |
| 4 bed detached | 4.5 | 3728 | 3939 | £0.140 | £522 | £86 | £280 | £186 | £1,074 | £8,442 | £1,992 | £6,098 | £4,536 | £21,068 | £13,914 | £7,154 |
| large 4 bed detached | 5.7 | 4722 | 5623 | £0.140 | £661 | £110 | £354 | £236 | £1,360 | £10,693 | £2,523 | £7,725 | £6,475 | £27,416 | £17,683 | £9,732 |